FOOD PRODUCT DISPENSER WITH CLEANSING MECHANISM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-In-Part of U.S. Ser. No. 10/328,826, filed December 24, 2002, the content of which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates to food product dispensing equipment and, more particularly, to the cleansing of areas of a food product dispenser with reduced operator input.

Background of the Invention:

In the foodservice area, post-mix beverage dispensers are well known which mix a concentrate or syrup with several measures of water and then dispense the mixture on demand to reconstitute a hot or cold beverage such as juice, coffee or tea. Serious sanitary problems may occur with microbiologically sensitive products such as low acid starting components that can enter into the composition of an on-demand prepared beverage. Other types of food dispensers may easily be subjected to bacterial contamination and growth such as soft ice cream serving machines.

For instance, milk is naturally a low acid fluid comprising a relatively balanced proportion of proteins, lipids and fluids with a pH of about 6.7. This formulation provides a favorable ground for critical bacterial growth. Milk can rapidly spoil when it comes into contact with contaminated moisture, dust, fluid, etc., and thus proper handling and dispensing of such a product can be challenging.

Therefore, a food dispenser handling liquid milk based components requires regular and thorough

cleansing with appropriate cleansing solutions to remove food residues and control microbiological growth in the tubing and mechanical parts that are in contact with the food product, such that they are cleansed properly. If done manually, this process is very laborious, time consuming and expensive in manpower. The cleaning process requires disassembly and re-assembly of the main functional parts of the machines. For instance, employee labor required to properly clean a cappuccino delivering machine or a visual bowl dispenser requires an average of 30 minutes a day. Furthermore, neglect or error in the cleansing process may not only affect the quality of the beverage, but also lead to serious hygienic hazards.

US Patent 6,287,515 to Koosman et al. relates to a cleaning and sanitizing assembly for clean-in-place ("CIP") food and beverage automatic dispensing machines. The assembly includes at least one water line and at least one sanitizer line to introduce at least one sanitizer to condition water from the at least one water line. The at least one sanitizer may be ozone generated by an ozone generator from air filtered and dried in an air filter/dryer and then added to the water in an air flow apparatus. Typically, the sanitized water is introduced into the dispensing machine through a tank which normally contains the food product mix. The sanitized water is dispersed into the tank through a rinse tube or a spray nozzle extending across the top of each reservoir. Both the rinse tube and spray nozzle may be moved away from the tank should access to the tank become necessary. A cover over the rinse tube and spray nozzle prevents splashing of the sanitized water. From the tank, the sanitized water proceeds throughout the dispensing machine to self-clean food and beverage contact surfaces. However, using an ozone generator with

this system has a number of disadvantages. Ozone generators tend to be expensive and bulky. The U.S. Environmental Protection Agency has placed also strict limits on ozone concentrations in the air. Ozone can damage the lungs when inhaled. Thus, ozone devices used for purifying water need to provide protection against the ozone being released from the water and creating high local ozone concentrations in the air surrounding the dispenser. Ozone generators also require high voltage generation since they normally rely on using a corona discharge to create ozone from oxygen. As a result, safety considerations arise due to the use of high voltage. Sometimes a purified oxygen source is also required. Moreover, since ozone is very reactive, it cannot be stored in water, and must be generated on demand by the system.

US Patent 6,240,952 to Schroeder relates to an aseptic product dispensing system that includes a sanitary connection assembly interposed in fluid communication with a substantially conventional aseptic product source and a substantially conventional product dispenser. The sanitary connection is provided with an automated cleaning system whereby a combination of pressurized gas, flushing fluid and/or sanitizing solution may be injected into, and thereafter evacuated from, the sanitary connection assembly. A controller is connected to each source for selectively delivering the selected fluid to sanitary connection and throughout the dispenser. The selected fluid is then evacuated through the terminal valve of the dispenser. The cleaning protocol is such that water is circulated first, then a sanitized fluid is circulated and maintained for a certain time in a soak cycle. Finally, a pressurized gas is circulated to displace water and/or sanitized solution

remaining in the system up to the dispensing valve. This clean-in-place system is cumbersome and complicated due to the number of sanitizing/rinsing lines and the same number of sanitizing/rinsing sources corresponding to those lines. Therefore, this system is more adapted for being installed outside and in connection with a traditional dispenser. Furthermore, the system is very much sanitizer consuming in the sense that the sanitizer flows through the dispenser and is evacuated through the dispensing valve. For reducing the volume of sanitizer flowing through the dispenser, the cleaning protocols provides a soaking cycle in which the sanitizer remains for a certain time within the system. However, in order to be effective, soaking must be maintained during several hours which means that a full cleaning protocol can only be carried out overnight.

Sanitization of food product dispensers known in the art typically takes a significant amount of time to complete. The complete rinsing and cleaning cycles including times for heating the cleaning solutions can take anywhere from 20 minutes to more than an hour for a traditional food product dispenser which is generally commercially feasible only at particular times in a day. Dispensing certain products, such as hygienically sensitive products, requires more frequent cleaning. Growth rates of microorganisms, for example, can lead to their number doubling as fast as every half hour, which can lead to unhealthy numbers of microorganisms in a matter of hours. Chemical sanitizers require full contact to the flow path and all surfaces to be cleaned.

Patent EP 0 245 641, titled "Machine for the treatment and/or the preservation of beverage or liquid or pasty food mixes", describes a system whereby a food/beverage dispenser may be maintained in "sterile"

conditions at the point whereby the dispensed product leaves the dispenser nozzle, i.e. comes into contact with the external environment.

Similarly, GB2367105, titled "Cleaning Conduits, Especially in Milk Vending Machines", details a control system that monitors either time, volume or number of dispenses since the last cleaning operation in order to auto-initiate the next cleaning. This system, however, is not designed to fit a post-mix beverage dispenser, where milk comes not only in contact with an outlet pipe, but contacts a much more tortuous path including mixing bowl, whipper, and nozzle. GB2367105 also recommends the concurrent use of ultraviolet light for purposes of sanitization, which is impractical in a post-mix dispenser.

Therefore, there is a need for a clean-in-place system that is more convenient, less labor intensive and time consuming than in known systems that provides assurance as to the hygienic state of the dispenser.

SUMMARY OF THE INVENTION

The invention relates to an automated food product dispenser including a food delivery mechanism, a cleansing mechanism and a controller. The food delivery mechanism includes a food source configured for receiving a food or food component, a food conduit associated with the food source for receiving the food or food component therefrom, and a dispensing mechanism configured for dispensing servings of the food or food component from the conduit along a dispensing path. The cleansing mechanism includes a cleansing conduit associated with the food delivery mechanism for directing a cleansing fluid along a cleansing fluid path in cleansing association with the food delivery mechanism under

conditions for performing a cleansing operation on at least a portion of the dispensing path. The controller is operably associated with the cleansing mechanism for activating the cleansing mechanism to cleanse the portion of the dispensing path automatically in response to predetermined conditions. The controller, delivery mechanism and cleansing mechanism are configured to switch between the dispensing of the servings and the cleansing operation at a plurality of intervals during a day without substantial intervention from an operator.

In accordance with a further aspect of the invention, the cleansing mechanism can be configured for conducting the cleansing operation without a substantial interruption of the delivery mechanism. Preferably, the cleansing operation has a duration of between about 10 and 20 minutes.

In accordance with another aspect of the invention, a dispenser is provided that further includes an operator annunciator, wherein the controller is operably associated with the annunciator to cause the annunciator to prompt an operator to activate the cleansing operation. The dispenser can also include at least one of a timer and a sensor, the timer configured for timing intervals between cleansing operations, wherein the controller is associated with at least one of the timer and the sensor for activating the cleansing mechanism based on information received from at least one of the timer and the sensor.

In accordance with a further aspect of the invention, the cleansing operation includes a sanitizing operation with hot water. In accordance with this aspect of the invention, the sanitizing operation is configured for automatically delivering water at a temperature between 75°C and 95°C at a predetermined time.

In accordance with another aspect of the invention, the cleansing mechanism can be configured for performing first and second cleansing operations that are different from each other. The controller can be configured for automatically operating the cleansing mechanism for selectively conducting the first or second cleansing operation. The first cleansing operation can include a sanitizing operation, and the second cleansing operation can include a cleaning and sanitizing operation. Moreover, the first cleansing operation can be cleaning operation, and the second cleansing operation can be a sanitizing operation. The controller can be configured to conduct the first cleansing operation several times per day. The cleansing mechanism can be configured to conduct the first cleansing operation using a cleansing fluid including at least one of (i) a detergent, (ii) a caustic material, and (iii) an acid material and the second cleansing operation using hot water.

In accordance with yet another aspect of the invention, the dispenser can be configured to dispense servings of up to about 10 servings at a time sized for individual consumption. The dispenser can also be configured to dispense a single serving at a time.

In accordance with still a further aspect of the invention, the cleansing mechanism can be configured for recirculating the cleansing fluid through the cleansing fluid path. The dispenser can further include a heating device configured to heat the cleansing fluid as the cleansing fluid is recirculated through the cleansing fluid path. The cleansing mechanism can also include a reservoir in fluid communication with the cleansing fluid path configured to hold a volume of the cleansing fluid.

In accordance with another aspect of the invention the controller can be configured to activate the cleansing mechanism at predetermined intervals for sanitizing a portion of the delivery mechanism.

In accordance with still a further aspect of the invention, the dispenser can further include a dispenser housing that houses the food source, food conduit, dispensing mechanism and cleansing mechanism. Thus, the dispenser can be configured such that it is unnecessary for an operator to connect an external source of food product or cleansing solution to perform a dispensing or cleansing operation.

In accordance with yet another aspect of the invention, the cleansing mechanism can be operatively associated with the food conduit and dispensing path and configured to cleanse each of the food conduit, dispensing mechanism and cleansing mechanism.

The invention also relates to a method for operating a food product dispenser. The method includes dispensing servings of a food or food component from a food delivery mechanism along a dispensing path; directing a cleansing fluid along a cleansing fluid path which is operatively associated with the food delivery mechanism to conduct a cleansing operation on at least a portion of the dispensing path; and switching between the dispensing of the food or food component and conducting the cleansing operation at a plurality of intervals during a day without substantial intervention of an operator.

In accordance with a further aspect of the invention, the cleansing fluid can include water that is directed along the cleansing fluid path to sanitize a portion of the fluid path. The water can be directed at an average fluid velocity between about 0.2 m/s and 2.0

m/s to cause flow along the path. Moreover, the water can be directed at a temperature between about 75C and 95C. The fluid can be directed once about every ten minutes to every 12 hours. Moreover, the water can be directed for between about 30 seconds to 30 minutes.

In accordance with another aspect of the invention, the first cleansing operation is conducted at a first interval a plurality of times before a second, different, cleansing operation is conducted at a second interval. The method can further include heating the cleansing fluid in the fluid path.

In accordance with still another aspect of the invention, the method can further include automatically determining with a controller device when a cleansing operation will begin, and sending a cleansing start signal to initiate the cleansing operation. The cleansing start signal can automatically start a cleansing operation, and/or it can notify an operator to activate a cleansing operation.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and are intended to provide further explanation of the invention claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute part of this specification, are included to illustrate and provide a further understanding of the system, method and machine readable program of the invention. Together with the description, the drawings serve to explain the principles of the invention, wherein:

FIG. 1 is a schematic representation of a representative embodiment of the automated food product

dispenser in accordance with the invention showing all major components of the dispenser;

FIG. 2 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing the milk manifold;

FIG. 3 is a partial schematic representation of the automated food product dispenser of FIG. 1 also showing a control panel and controller;

FIG. 4 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing the dispensing nozzle in a dispensing position;

FIG. 5 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing the dispensing nozzle in a cleaning and/or sanitizing position;

FIG. 6 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing a cross-sectional view of the milk manifold;

FIG. 7 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing the tip of the spear;

FIG. 8 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing a cross sectional view of the milk manifold and a fitmented hose of a milk container assembly connected thereto;

FIG. 9 is a partial schematic representation of the automated food product dispenser of FIG. 1 showing the fitment and hose of the milk container assembly and pinch valve of the dispenser;

FIGS. 10-12 are partial schematic representations of the automated food product dispenser of FIG. 1 showing the fitment in accordance with the invention;

FIG. 13 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a cappuccino/latte dispensing operation;

FIG. 14 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a post drink dispensing rinse operation;

FIG. 15 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a daily hot water sanitization operation;

FIG. 16 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a daily CIP initial rinse operation;

FIG. 17 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a CIP reservoir draining operation;

FIG. 18 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a circulation cleaning loop operation for cleaning the mixing bowl and nozzle;

FIG. 19 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a daily circulation cleaning loop operation for additionally cleaning the milk manifold;

FIG. 20 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a daily CIP reservoir filling operation; and

FIG. 21 is a schematic representation of the automated food product dispenser of FIG. 1 showing flowpaths that are active during a milk manifold rinse operation during inactivity.

FIG. 22 is a schematic representation of fluid temperatures reached at different portions of a food product dispenser during a hot water sanitizing rinse cleansing operation.

FIG. 23 is a schematic representation of fluid temperatures reached at different portions of a food product dispenser during a hot water CIP cleansing operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the present preferred embodiments of the invention, an example of which is illustrated in the accompanying drawings. The device presented herein is particularly well suited for dispensing liquid or powder based food products. The term "food product" includes anything edible in a solid or liquid form that can be dispensed by a dispenser, including but not limited to beverages, dessert toppings, dairy and non-dairy products and the like. The present invention is particularly well-suited for mixing and dispensing milk-based liquid food products, since it contains a programmable self-cleaning mechanism that can help to avoid spoilage of milk-based food product within the food fluid path. The invention also relates to the automatic cleaning of beverage dispensers that use microbiologically sensitive starting components such as milk or milk liquid based concentrate, as well as other food products such as dessert toppings and the like. In particular, hot water can be used to sanitize such equipment when circulated through the

dispenser at predetermined frequencies, durations and temperatures. Moreover, while refrigeration can be used in some embodiments of the invention, such as for dispensing refrigerated products, it allows non-refrigerated products to be dispensed.

The supply of cleansing fluid can be produced within the dispenser by mixing a chemical cleaning concentrate, supplied from a concentrate supply, with water supplied from a water supply to generate a chemical cleaning agent for use as the cleansing fluid. As used herein, the term cleansing generally includes a fluid used to clean, rinse or sanitize the fluid path, and is intended to broadly include many different types of cleaning and sanitizing processes using different cleansing agents. Cleaning generally refers to de-soiling the fluid path while sanitizing generally refers to the reduction of microbiological loads including spore loads.

Applicants have discovered through direct experimentation that the use of hot water alone as a cleansing fluid, particularly as a sanitizing agent, circulated in predetermined intervals under certain conditions by a cleansing mechanism, including at preselected temperatures, for set periods of time, can provide reductions in growth of microbiological materials. Also, the cleansing mechanism can optionally include a reservoir configured to receive a buffer volume of the cleansing fluid, a loop line associated with the reservoir and configured to provide circulation of the fluid from the reservoir through the fluid path and back to the reservoir, and a drain associated with the assembly for removing fluid therefrom.

Preferably the cleansing mechanism is configured for conducting the cleansing operation without

a substantial interruption of the delivery mechanism. For example, during ordinary business hours, it is preferred that the cleansing mechanism does not interrupt operation of the machine for more than 10-20 minutes, since it is not desirable to interrupt dispensing for a period of time in excess of this during business hours. More preferably, the cleansing mechanism only operates for 5-15 minutes or even more preferably between 30 seconds and 7 minutes. Thus, substantial interruption of the delivery mechanism can be avoided.

In addition to or instead of a buffer reservoir, it is also possible with the invention to use an inline heater in the fluid path (such as heating device 990 depicted in Fig. 18) to continuously heat and recirculate a small amount of water or other cleansing fluid. Since the reservoir can be eliminated, this can result in a smaller food product dispenser design with an accompanying cost savings. The cleansing fluid can be produced by heating water from the water supply in the heater at a temperature and circulating the fluid at intervals and for durations effective to provide a sanitizing effect. Either way, the cleansing fluid cleans the fluid path as it flows thereon or therethrough.

Moreover, a controller can be used for controlling a cleansing process. The controller will generally include a timer or other periodic energizing device. The dispenser can also include a control panel, and a controller, such as a central controller, can be programmed to run the full cleansing operation in response to user demand. Alternatively or additionally, the central controller can be programmed to automatically run a time controlled delivery of one cleaning cycle of the cleansing fluid through the fluid path, followed by a

time controlled delivery of at least one sanitizing cycle of cleansing fluid through the fluid path.

If it is desired to use a cleansing fluid besides water, the dispenser can include a source of cleansing fluid, such as a removable container that contains the cleansing fluid concentrate. The cleansing fluid source is preferably connected in a fluid path to a shut-off valve that is controlled by the controller to deliver and to optionally meter an amount of cleansing concentrate. This concentrate can be circulated without the use of a reservoir, or may be alternatively circulated through a reservoir for preparing the cleaning agent for cleansing of the fluid path.

The circulation of the cleansing fluid can be automatically conducted at periodic intervals of non-use of the dispenser upon demand by a user or automatically at predetermined time intervals. If desired, the fluid path can be pre-rinsed prior to circulation of the cleansing fluid. Also, a portion of the fluid path can be closed off so that remaining portions of the fluid path can receive the cleansing fluid.

In accordance with a further aspect of the invention, a machine readable program is provided that further includes instructions for controlling a device to recirculate the cleansing fluid in a loop from through the fluid path. The cleansing fluid can be recirculated by, for example, a pump controlled by the controller or a valve manifold capable of driving a flow through the fluid loop by introducing liquid at a higher pressure through the fluid loop. Optionally, portions of the dispenser can be provided for periodically draining and discarding the recycled cleansing fluid from the dispenser. Such portions can include, for example, a solenoid operated valve located in a drain line that may

be selectively opened by the controller to permit gravity or pressure driven draining of the reservoir.

Additionally or alternatively, a device may also be provided to direct the cleansing fluid to a mixing bowl within the dispenser for cleaning the mixing bowl and the fluid path arranged downstream of the mixing bowl. Such a device can include, for example, a valve manifold containing solenoid operated valves that can be selectively opened or closed by a controller wherein the manifold may be selectively configured to direct hot water or water based solution containing a cleaning concentrate to the mixing bowl and portions of the fluid path downstream from the mixing bowl.

In further accordance with the invention, a machine readable program may be provided, such as in the controller. The controller can be configured by the machine readable program to cleanse the mixing bowl using the cleansing mechanism by filling the bowl to overflow with the cleansing fluid. The cleansing device can include a solenoid actuated valve manifold controlled by the controller to fill the mixing bowl to an overflowing condition. A device for collecting fluid that overflows the bowl can include, for example, a skirt surrounding the mixing bowl that is connected to a drain line. A device for selectively directing the collected fluid back to a reservoir can include a solenoid actuated valve manifold controlled by a controller that is configured to selectively open and close valves and/or turn on pumps to direct the collected fluid back to the buffer reservoir and/or to a drain to remove the collected fluid from the dispenser.

Additionally or alternatively, the machine readable program can be further configured to automatically operate the cleansing mechanism to conduct

circulation of the cleansing fluid at periodic intervals of non-use of the dispenser or upon demand by a user.

For purposes of explanation and illustration, and not limitation, an exemplary embodiment of the device in accordance with the invention is shown in Fig. 1 and is designated generally by reference character 100. While a particular food product dispenser is depicted herein, the invention is applicable to food dispensers of virtually any configuration wherein it is desired to periodically cleanse the system to maintain it. Such dispensers can include dispensers configured to dispense food products such as juice, drinking yogurt, dessert toppings and the like.

In accordance with the present invention, the automated food product dispenser comprises an interface connection that is configured to establish a supply of a food product such as a milk based fluid from a food source, such as a milk based fluid reservoir, a mixing device configured to receive the milk based fluid and prepare a milk based product, a nozzle in fluid association with the mixing device to dispense the milk based product, a fluid path configured to direct the milk based product to flow from the interface connection through the mixing device to the nozzle, and a cleansing mechanism located in the dispenser and including a supply of cleansing fluid and a flowpath which is configured to deliver the cleansing fluid to or through the fluid path.

Dispenser 100 includes interface connection 233 that is configured to establish a supply of a milk based fluid 211a from a food source such as milk based fluid reservoir 211, a mixing device 400 configured to receive the milk based fluid 211a and prepare a milk based product, a nozzle 500 in fluid association with the mixing device 400 to dispense the milk based product, a

food conduit or fluid path 600 configured to direct the milk based product to flow from the interface connection 233 through the mixing device 400 to the dispensing mechanism, such as nozzle 500, and a cleansing mechanism 700 located in the dispenser 100 and including a supply 987a of cleansing fluid and a flowpath 800 which is configured to deliver the cleansing fluid to or through the fluid path 600. Cleansing mechanism 700 is preferably at least partially or completely contained within housing 1500 of dispenser 100 (See Fig. 3). Even more preferably, it is not necessary to connect an external source of cleansing fluid (e.g., detergent) to dispenser 100 to perform the cleansing operation.

Each of the above referenced features will be described below in further detail, after which the device as a whole will be discussed, including some exemplary modes of product preparation and delivery as well as self-cleaning operations of the device.

Fig. 2 depicts the interface connection 233 and structures associated therewith. The interface connection 233 is configured to establish a supply of a milk based fluid 211a from a milk based fluid reservoir 211 to a dispensing line 620. The manifold 230 includes a disposable sub-assembly or container assembly 210 that is removably attached to a manifold 230. The manifold 230 comprises a housing 232 having an interface connection 233 for establishing beverage or food fluid connection from the container assembly 210 to a dispensing line 620. The manifold system is adapted for being traversed and flushed through a flushing line 235 by cleansing fluids. The cleansing fluids may encompass hot water 820 or cold water 810, chemical agents, steam, and combinations thereof. The cleansing fluids can be selectively sent through flushing line 235, for example, by selectively

opening and closing valves that may place flushing line 235 in fluid communication with a source of cleansing fluid (See Fig. 1) wherein the valves are controlled by a programmable controller 1000.

While a milk-based fluid is depicted to be dispensed in this embodiment, other embodiments can dispense other products. Other types of food products can also be dispensed, including, for example, other microbiologically sensitive food products such as milk-based beverages as well as dairy-based desserts and the like. Other non-microbiologically sensitive food products can also be dispensed using dispenser 100. Moreover, food products can be provided in concentrated as well as ready to use (i.e., un-concentrated) form. Various concentrated forms such as liquid and powdered concentrate forms can be used.

The container assembly 210 preferably includes a package or reservoir 211 containing the food product and a hose 212 that terminates by a fitment 300. The package or reservoir 211 may typically be a bag-in-box type package or any similar disposable flexible package that is easy and convenient for transportation and storage. However, other options are possible, such as a receiving bin that can be filled by an operator. The hose 212 is preferably directly sealed or crimped to the package port 215 and be made of materials that are compatible for sealing with the package material. The container assembly 210 with its membrane 350 may preferably be sterilized, such as by irradiation, prior to filling. Filling of the food liquid is preferably aseptically done. Aseptic filling may be carried out by a filling port or aperture provided in the package itself or by filling the fitment 300 attached to the hose which is subsequently properly sealed. Therefore, such a

container assembly 210 can be maintained aseptic until the membrane 350 is punctured or, alternatively peeled off which provides the benefit to transport, store and load the container assembly 210 in the dispensing unit at ambient temperature without need for refrigeration. Such a flexible reservoir and hose assembly is described in further details in US patent 6,024,252 to Clyde entitled: "Dispenser System"; the content of which is expressly incorporated herein by reference.

The container assembly 210 is connected to the manifold system 230 with its fitment 300 connected to the interface connection 233 and the hose 212 engaged in a pinch valve 260 or similar structure that can maintain the upstream portion 212a of the hose 212 and package or reservoir 211 sterile. Additional valves such as valve 216 and a pump 203 are usually provided to ensure a control of the flow of product to the dispensing line 620 (See Fig. 1).The manifold 230 comprises retaining means 236 that complementarily engages in a convenient and removable manner to the terminal fitment 300 of the invention. The configuration of the coupling means 236 may widely vary depending upon the type and shape of the fitment to be locked at the interface connection 233. The coupling means should be able to provide a watertight connection at the interface connection 233 in order to establish a reliable and secure fluid communication between the container assembly 210 and the dispensing line 620 of the manifold 230. Preferably, there is provided a spring loaded holding system 237 adapted to engage the coupling means 236 of the fitment 300 that elastically forces the fitment 300 to the interface connection 233. It is clear that the connection between the fitment 300 and the manifold system 230 could be carried out by any other equivalent means such as by cam

or lever type mechanisms to provide substantially the same result without departing from the spirit of the invention.

In a cleansing mode, the manifold system 230 is capable of directing cleansing fluid within the fitment 300 up to the pinch point 266 so as to regularly cleanse this portion of the container assembly. In such a configuration, the pinch valve 260 ensures the upstream part of the container assembly 210 remains isolated and sterile. Importantly, it can be easily understood that the shortened construction of the fitment 300 enables to effectively reduce the downstream portion 212b of the hose 212 that requires cleansing. The fitment 300 also gives very little opportunity for micro-organisms to settle as contact with the fluid is confined along a short tubular internal surface. Hence, the hygienic conditions of dispensed food products can be successfully improved and the risks of bacterial contamination and growth are proportionally reduced. As a result, an aseptically processed container containing low acid concentrate such as milk concentrate with relatively low water activity can be dispensed at ambient temperature in the dispensing unit without requiring refrigeration of the container.

In accordance with the invention, an automated food product dispenser is provided that further comprises a mixing device configured to receive the food product and prepare, for example, a milk based product.

Figs. 1 and 3 illustrate a mixing device 400 in accordance with the invention. In using this embodiment of the invention, an operator selects the desired beverage, for example a cappuccino, from the command panel 1100 of the device. In response to this user input, an electronic controller 1000 initiates the

preparation process of the milk-based beverage and operates the different parts of the dispenser 100 apparatus described herein. A flow of food product such as a milk based fluid 211a from reservoir 211 can be supplied via the manifold 230 as described above. A pump 203, preferably a peristaltic pump, can provide pressure to force milk based fluid 211a past pinch valve 260 to a mixing bowl 406, which is connected to a whipper 409.

The mixing bowl 406 and whipper 409 are part of a mixing device 400. While milk based fluid 211a flows to the mixing bowl 406, hot water supply valve 950 is opened to begin a flow of hot water 820 from a hot water 820 tank 751 to the mixing bowl 406 where hot water 820 and milk based fluid 211a begin to mix together. Mixing bowl 406 is activated for mixing the blend of hot water 820 and milk based fluid 211a. Then the hot reconstituted milk mixture 211b flows from the bowl 406, through the whipper 409, through the dispensing nozzle 500 and into a receptacle, such as a cup 516, which is received in a dispensing area 418. This step occurs for a predetermined period to achieve dosage of hot water 820 and milk based fluid 211a for preparing an individual serving of the beverage. After this period, pump 203 is turned off. The dispensing area 418 is preferably dimensioned for receiving a drinking cup or glass, and for positioning the nozzle at less than about 10 cm above the beverage surface, although other distances may be employed in other embodiments.

After a predetermined delay, preferably of about one second, whipper 409 is shut off, and a coffee pump 411 is turned on for delivering coffee concentrate, preferably in controlled doses, from a coffee container 412 to the mixing bowl 406. Alternatively, in the case the beverage product prepared is a hot chocolate

beverage, pump 411a is turned on for sampling chocolate concentrate from a chocolate container 412a. Containers 412 and 412a are preferably of the same or similar kind of construction as the reservoir 211, e.g., hermetically sealed removable pouches, but may also be very different from each other in other embodiments. Coffee and hot water 820 flow into the mixing bowl 406, through the whipper 409, and through the nozzle 500 and into the cup 516, for a predetermined time and at a selected rate to achieve desired dosage of coffee and hot water. After the coffee dosage has been achieved, coffee pump 411 is turned off. While pump-delivered liquid concentrates are embodied herein, powdered concentrates may also be used delivered by way of an appropriate mechanism such as a screw auger and the like. Moreover, dispenser 100 can be used to mix two or more food products to be dispensed from concentrated or ready-to-use forms.

In further accordance with the invention an automated food product dispenser is provided that utilizes a nozzle in fluid association with the mixing device to dispense the food product. As shown in Fig. 3, a dispensing nozzle 500 is provided. Preferably, the nozzle 500 is capable of self-cleaning. Referring to Fig. 4, nozzle 500 comprises a body 508 of generally cylindrical shape. Body 508 comprises a middle section 508a, and two end sections 508b, and 508c, each having a smaller diameter than that of middle section 508a. Body 508 is provided with a through conduit 550 extending longitudinally at the center of body 508. Conduit 550 comprises a first end portion 551 to which a nozzle head 512 is connected and a second end portion 552 intended to be connected to a fluid feed line via a conduit. In this example, nozzle head 512 is screwed onto the free end of section 508b of body 508 and a connector 514 is secured

to the free end of section 508c. Nozzle head 512 comprises a channel 509 bent at a right angle having a first portion 509a connected to conduit 510 and a second portion 509b opening out onto the exterior and in which a beveled cylinder 513 is screwed. Beveled cylinder 513 delimits with portion 509b of channel 509 an annular fluid or beverage orifice 518, the shape of which determines the shape of the fluid jet. In the example illustrated in Fig. 4, the jet has the shape of a cone C shown in dotted lines. Connector 514 thus defines a fluid or beverage inlet 516 and the fluid or beverage orifice 518 defines a fluid or beverage outlet.

It will be noted that screwing nozzle head 512 onto body 508 and screwing beveled cylinder 513 into nozzle head 512 enables these elements to be easily interchanged and makes dispensing nozzle 500 advantageously flexible. In particular, dispensing nozzle 500 can be rapidly and easily adapted to beverages requiring different sizes for beverage outlet 518 or different jet shapes. Dispensing nozzle 500 further comprises a collector member 520 that has the general shape of a cylindrical sleeve open at both ends. Collecting sleeve 520 has a cylindrical rear section 520a extended by a converging truncated front section 520b. Sleeve 520 is secured in brackets 506a, 506b. In the example shown, sleeve 520 is made of two parts connected to each other by a plurality of screws 522 extending longitudinally in the thickness of the walls of said sleeve parts. Body 508 and nozzle head 512 are guided and slide axially inside sleeve 520.

More precisely, body 508 and nozzle head 512 are mobile relative to sleeve 520 between a first position, called the dispensing position, shown in Fig. 4, in which nozzle head 512 is released from sleeve 520,

i.e. it is outside sleeve 520 so as to be able to dispense a beverage into a receptacle R, and a second position called the cleaning position shown in Fig. 5, in which at least a part of sleeve 520 is placed in front of beverage outlet 518 to collect a cleaning fluid 984a coming out of the beverage outlet 518.

In the dispensing position, nozzle head 512 projects from the front section 520b of sleeve 520 and a beverage B arriving via conduit 550, symbolized by a bold line in Fig. 4, can be dispensed through beverage outlet 518 of nozzle head 512 into a receptacle R arranged below beverage outlet 518.

In the cleaning position, inner wall 524 of sleeve 520 defines with the outer surface 526 of body 508, a cleaning chamber 528 in which the nozzle head 512 and in particular beverage outlet 518 is housed. Cleaning chamber 528 communicates with the exterior via a drain orifice 530 located in an inner wall of sleeve 520. Depending on the particular case, drain orifice 530 is connected either to the sewage system (not shown), or to a recuperation tank (such as CIP tank 980, See Fig. 1) in order to allow the cleaning fluid to be put back into circulation in a closed circuit via a tank and a pump device. Two sealing gaskets, front gasket 532 and back gasket 534, are arranged on either side of beverage outlet 518, and act to seal chamber 528.

Preferably, front gasket 532 is formed by a sealing joint and is arranged between a front surface 536 of truncated section 520b around the front opening of sleeve 520 and a complementary surface 538 defined by a collar 540 provided in the front part of nozzle head 512.

It will be noted that collar 540 is located outside sleeve 520 whether dispensing nozzle 500 is in the dispensing position or in the cleaning position. It

will be noted that frontal surface 536 and complementary surface 538 are preferably planar in order to assure proper sealing of chamber 528 in the cleaning position. Back gasket 534 is formed by a sealing joint arranged between the cylindrical portion of inner wall 524 of sleeve 520 and median section 508a of body 508. Typically, front sealing gasket 532 is an 0-ring type joint and back sealing gasket 534 is a lip seal type joint. In the cleaning position, body 508 is moved so that collar 540 abuts against frontal surface 536 in order to make chamber 528 watertight.

Thus, where a cleansing fluid in addition to or besides water is to be used, a detergent-containing fluid or cleansing solution, 984a symbolized by a bold line in Fig. 5, passing through conduit 550, can be directed into conduit 509 of nozzle head 512, then into chamber 528, and around nozzle head 512 before flowing through outlet 530 into a drain or a recuperation tank. Appropriate cleansing media besides water include detergents, caustic and acid solutions, steam, formaldehyde, ozone, hot water and ultraviolet light, among others.

In order to assure relative movement between sleeve 520 and body 508, body 508 is connected to actuating means 542 secured to base plate 504. Preferably, actuating means 542 are formed of a solenoid electromagnetic actuator 544 associated with a return spring 545. The rod 546 of actuator 544 is secured to section 508a of body 508 and return spring 545 is arranged around rod 546 between body 508 and actuator 544.

Thus, in response to a control signal originating from a controller 1000 (See e.g., Fig. 3), actuating means 542 allows dispensing nozzle 500 to be automatically brought into its dispensing and cleaning

positions. More precisely, in the absence of any signal on actuator 544, the solenoid is de-energized and return spring 545 urges body 508 in the direction of arrow F1 to bring dispensing device 100 into the dispensing position shown in Fig. 4. In the presence of a signal on actuator 544, the solenoid electromagnetic actuator 544 is energized and tends to urge body 508 in the direction of arrow F2 to bring dispensing device 100 into the cleaning position shown in Fig. 5. It goes without saying that any other type of actuator can be used provided it allows a translation movement to be impressed on body 508 with respect to sleeve 520. By way of example, one could envisage replacing electromagnetic actuator 544 with a drive device with gears or by an electric actuator.

Further details regarding the self-cleaning nozzle are described in co-pending US patent application Serial No. 10/133,126 by Peter W. Carhuff et al. filed October 11, 2002 entitled "FLUID DISPENSING DEVICE WITH SELF-CLEANING NOZZLE AND METHODS OF USE" which, is incorporated herein by reference in its entirety.

While the above actuable nozzle has been described herein, an ordinary nozzle can also be used in an alternate embodiment of the invention. Such a nozzle can be cleansed in a cleansing operation by directing a cleansing fluid therethrough. In accordance with this alternative embodiment, a recirculation loop for cleansing can be established by, for example, an operator attaching a tube to the nozzle during a cleansing operation. In this manner, the dispensing nozzle can be configured to be placed in selective fluid communication with cleansing mechanism 700.

In accordance with another aspect of the invention, and referring to Figs. 1 and 3, after a small delay to deliver the remainder of hot water 820 required

by the recipe, the hot water supply valve 950 is turned off. The remainder of the hot water 820 after the food product (e.g., milk based fluid 211a and coffee) have been added has the advantage to allow for recovery of most of the food product remaining in the whipper bowl 406 and whipper 409 from the system and into the cup 516.

Then, a showering valve 413 is turned on for preferably several seconds, as described below, to supply water 810 to a spraying nozzle 414 to spray water 810 on the foam on the top of the cappuccino beverage prepared in the cup 516. In the example of coffee dispensing, this spraying phase acts to wash the brown coffee material from the top layer of the foam to whiten the upper layer of the cappuccino froth topping. It also breaks larger bubbles and moistens the foam to refine the froth structure and to give the froth topping a whipped and creamy appearance and to increase the creaminess and homogeneity of its appearance.

To complete an appropriate spraying of the foam layer and achieve a satisfying whitening and appearance of the foam, care should be given to the water droplet size. A suitable droplet size is obtained by a combination of the nozzle orifice size, the nozzle orifice design and the pressure of the water 810 supplied to the spraying nozzle. The nozzle 414 has preferably an orifice size of about 0.1 to 1 mm, more preferably of from 0.50 to 0.85 mm, and most preferably between 0.7 mm and 0.8 mm. Optimum results were obtained with a nozzle having an orifice size of 0.762 mm.

The nozzle 414 preferably operates to distribute droplets in a diverging configuration on the surface of the froth. A diverging configuration has proved to provide smaller droplets as compared to a straight configuration and form a widespread and uniform

washing effect on the froth without creating recessed areas on the surface, although a straight or other configurations can alternately be used. The nozzle 414 preferably has a tapered orifice adapted to form a divergent spray angle ranging of from about 45 to 60 degrees, more preferably about 50 to 55 degrees.

Further details regarding materials and methods for treating the foam using a water spray are described in co-pending US patent application Serial No. 10/268,777 by Peter W. Carhuff et al. filed October 11, 2002 entitled "FROTH SHOWERING" which, is incorporated herein by reference in its entirety.

In further accordance with the invention an automated food product dispenser is provided that further comprises a fluid path configured to direct the food product to flow from the interface connection through the mixing device to the nozzle.

As embodied herein and with specific reference to Figs. 1 and 2, the dispensing device 100 of the invention is shown to generally include the manifold 230 inserted in fluid communication with the reservoir 211 and a downward dispensing line 620 that can lead to a mixing device 400 as described above, to a delivery conduit 710 and the nozzle 500.

As embodied herein, the fluid path 500 includes any path that food products traverse, as well as any path traversed by a cleansing fluid. For example, during ordinary operation of the dispenser 100, the fluid path would include any surfaces that come into contact with a food product. This could, of course, include at least the reservoir 211, hose 212, fitment 300, interface connection 233, dispensing line 620, mixing device 400, delivery conduit 710 and nozzle 500 It could also include pumps 411 and 411a, containers 412 and 412a. The

number of concentrate containers, pumps, dispensing lines etc. that make up the fluid path depend only upon the desired complexity and type of the dispensing device 100.

In further accordance with the invention an automated food product dispenser is provided that further comprises a cleansing mechanism located in the dispenser and including a supply of cleansing fluid and a flowpath which is configured to deliver the cleansing fluid to or through the fluid path.

As embodied herein and with reference to Figs. 1 and 2, the sanitary manifold 200 in accordance with the invention includes manifold 230 and portions of the Clean-In-Place ("CIP") system. Portions of the CIP system can include, for example, clean in place or "buffer" reservoir 980 (if provided), valve 986 and cleansing valve 987 connected to containers 986a and 987a containing cleansing fluid, CIP pump 988, hot water tank 751, and valves 750, 755, 945, 950, 955, and 989. The CIP system can be used to cleans any portion of dispenser 100. However, any one of a variety of arrangements of valves, reservoirs etc. and flow lines can be used to dispense a food product and clean the system periodically in accordance with the invention. The CIP system may also be used for descaling purposes. In this case, a container of acidic solution may be arranged with a control valve to supply the acidic solution to the system. The acidic solution may be provided in a concentrated form and diluted with water in the CIP reservoir 980. Dispenser 100 can be outfitted, if desired, to descale the boiler (hot water tank 751) and associated equipment by circulating acidic solution therethrough periodically. Other portions of the dispenser can be similarly descaled.

With reference to Fig. 2, the manifold 230 is adapted for being selectively traversed and flushed by cleansing fluids such as hot water 820, steam and chemical sanitizing agents coming from cleaning line 703 or sanitizing line 704. The selection and opening of the cleaning line 703 or sanitizing line 704 can be made by means of valves 705, 706 controlled by controller 1000 (See Figs. 1 and 2). Typically, for milk-based concentrates, the sanitizing agents will be chosen from among the group including caustic soda, low foaming detergent solutions, or chlorinated or phenolated solutions. As mentioned above, however, hot water alone can be used for purposes of sanitizing. The cleaning fluid may also encompass descaling agents such as acid solutions.

In one embodiment of the invention, the cleansing fluid is circulated through the fluid path at average fluid velocities between about 0.2 m/s to about 2.0 m/s; even more preferably between about 0.4 m/s to about 0.8 m/s. When the cleansing fluid includes a detergent and/or caustic component, the cleansing fluid is preferably circulated at a fluid temperature between about 50C and 85C, even more preferably between about 60C and 75C. When the cleansing fluid includes an acid component, the cleansing fluid is preferably circulated at a fluid temperature between about 40C and 70C. Even more preferably, the acidic cleansing fluid is circulated at a fluid temperature between about 50C and 65C.

When the cleansing step is a rinsing step, it preferably has a duration between about ten seconds and ten minutes; more preferably between thirty seconds and five minutes; even more preferably between about one and three minutes. When the cleansing step is a cleaning step (e.g., using a detergent), it preferably has a

duration between about fifteen seconds and twenty minutes; more preferably between about thirty seconds and ten minutes; even more preferably between about one and five minutes.

With reference to Figs. 2 and 6, a preferred manifold 230 includes a housing 232 of substantially cylindrical shape. At a first end 231 of the housing 232 is provided an interface connection 233 adapted to receive in a removable manner the fitment 300 of the container assembly 210. The housing 232 has a hollow configuration with a central bore 744 to enable a moveable cleansing fluid line assembly 733 to be coaxially mounted within the central bore 744. The cleansing fluid line assembly 733 comprises a first connector 734 that defines an inlet 735 for the cleansing fluid to enter the manifold 230 at about 90 degrees relative to the longitudinal axis of the central bore 744. Connector 734 thus connects to a second intermediate L-shaped connecting part 736 of the line assembly that directs the flow of cleansing fluid along the longitudinal axis and connects itself to a third connecting part 737. The third connecting part 737 is attached to a projection member 738 that includes an axial conduit 739 for transporting the cleansing fluid up to a fluid port 741 located close to a terminal spear 743 of the projection member 738.

The spear 743 has a sharp end 732 capable of cutting a membrane 350 (See Fig. 2) of the fitment 300 upon actuation of the projection member 738 forward in a reciprocating manner. Since the parts 734, 736, 737 738 and 743 are fixedly attached together, the whole line assembly 733 can reciprocate along the bore 744 of the housing 232. As illustrated in Fig. 7, the spear 743 preferably comprises a plurality of circumferentially

oriented cutting splines 743a arranged to cut open the membrane 350 and provide a sufficiently wide opening in the fitment 300 for the flow of milk based fluid 211a to properly traverse the fitment 300 without retaining zones where solid deposits could easily settle. Furthermore, the splines 743a also play a role to direct the flow of cleansing fluid toward the fitment 300 and hose 212 of the container assembly 210.

As further embodied herein, a portion of the projection member 738 is closely guided in axial movement along the portion of bore 744 of an internal body 745 of the housing 232. The internal body 745 is attached by means of a connection means such as screws to a front body part 746. The front body 746 comprises a chamber 747 of larger diameter than the external diameter of the projection member 738 so as to demarcate an annular room that extends inwardly from the interface connection 233 to a discharge conduit 748 positioned at right angle with respect to the chamber 747. The chamber 747 and discharge conduit 748 form together a discharge line 760 that terminates by a discharge outlet 761. A sealing gasket 749 is provided between the internal body 745 and the projection member 738 to make the discharge line 760 inwardly watertight.

In the rear end of the housing 232 an actuator 762 is provided, preferably an electromagnetic solenoid actuator coaxially mounted on a rear hollow body part 763 of the housing 232. The actuator 762 is mounted in engagement with the cleansing fluid line assembly, more particularly to the second connector 736. The actuator 762 can be of a push-and-pull solenoid type. Thus, in response to a control signal originating from a control circuit, the actuator pushes on the fluid line assembly 733, in the direction of arrow A as shown in Fig. 6,

which has the effect to move the projection member 738 and its spear 743 forward in an inserted position in which the tip of the spear 743 extends beyond the interface connection 233. When the actuator 762 is de-energized, the projection member 738 stops in the inserted position. When the actuator 762 is energized again, it tends to push the line assembly 733 back in a retracted position, i.e., in the direction of arrow B, in which the spear 743 is located in a position inset relative to the interface connection 233. It can noted that the actuator 762 could also be of a push type only and combined with a return spring inserted between body part 745 and the connector that pushes the projection member 738 back in retracted position upon de-energization of the solenoid. As shown in Fig. 6, the rear body part 763 of the housing 232 comprises an elongated orifice 765 of a shape and size adapted for the inlet and connectors 734, 735 to move axially as an integral part of the whole fluid line assembly. Of course, the solenoid actuator 762 could also be replaced by equivalent actuating means such as a cam mechanism, a worm gear or a rack and pinion system. As illustrated in Fig. 8, the manifold 230 comprises coupling means that complementary engages a terminal fitment 300 of the container assembly 210. The configuration of the coupling means may widely vary depending upon the type and shape of the fitment 300 to be locked in place. The coupling means should be able to provide a watertight connection at the interface connection 233 in order to establish a reliable and secure fluid communication between the portion of hose 212 and the dispensing line 620 of the manifold system 230 and avoid risks of fluid leakage outside the system. In a preferred mode, as shown in Fig. 8, there is provided a spring loaded holder

766 having a ring shaped lip 770 adapted to engage a complementarily shaped annular groove 723 of the fitment 300. The fitment 300 is so urged in abutting contact with the end surface of housing 232 against a seal 771 placed at the periphery of the interface connection 233 by means of a retaining nut 768 that progressively forces on the holder 766 upon screwing on a portion of the body part 746 of the housing 232. Some elasticity is given on the holder 766 to avoid permanent deformation of the elements and compensates for backlash by a spring or other elastic means 780 that is inserted between holder 766 and body part 746.

It is clear the connection between the fitment and the manifold system could be carried out by other equivalent mechanical means such as by a cam type mechanism or a lever type mechanism to provide the same result without departing from the spirit of the invention. It is also clear that the receiving means of the fitment could also be formed from a protruding part as opposed to an annular groove and the holder formed from a recess instead of an annular lip wherein the protruding part of the fitment would complementary fit the recess of the holder.

Referring to Figs. 2 and 9, the manifold system 230 further comprises an external valve that is preferably situated as close as possible to the interface connection 233 and that externally engages the portion of hose 212 of the container assembly 210. The external valve is preferably a spring loaded pinch valve 260 with a pinching member 261, a pinch block 262 and a tension spring 263. The tension spring 263 constantly maintains a certain closing pressure of the pinching member 261 at a pinch point 266 on the hose and against the pinch block 262. Due to the tension of the tension spring 263, the

valve 260 acts passively in a rest configuration. The pressure exerted by the valve 260 is typically sufficient to hermetically close the hose 212 at the pinch point 266 when the pump 203 is not in action. Hence, the portion of hose 212 situated upstream the pinch point 266 can be maintained sterile in this rest situation. When the pump 203 is acting, the pressure exerted by the flow of the concentrate in the upstream part 212a of the hose 212 is sufficient to overcome the threshold tension value of the tension spring 263 and therefore to force the pinch valve 260 to open.

By virtue of the flow force created and direction of the flow, microbial substances can not attain the upstream portion of hose which remains sterile. In a cleaning situation where the cleansing fluid is pushed under pressure from the manifold system 230 within the fitment 300 and the downstream portion 212b of hose 212, the threshold tension of the pinch valve 260 can be raised to a higher value by pinch actuator 267 that exerts an additional pressure adding to the spring tension on the pinching member 261. Therefore, the threshold tension of the valve 260 is increased sufficiently above the cleaning fluid pressure to ensure that no cleansing fluid can enter the sterile portion of the container assembly 210. Therefore, in all conditions, the portion 212a of hose 212 past the pinch point 266 can remain safely sterile while the portion 212b of hose 212 prior the pinch point 266, which is no more sterile after breaking of the membrane 350, can be periodically cleaned and rinsed. As a result, the delivery conditions of a microbiologically sensitive fluid, e.g., milk concentrate, are safely controlled and refrigeration in the dispensing unit 100 is not necessary.

Referring again to Fig. 8, the cleansing operation will now be discussed when a new container assembly 210 is put in place and attached to the manifold 230. Since the container assembly 210 comprises external parts of the fitment and of the membrane 350 which can readily not be maintained sterile and which interface with the dispensing line 620 after the fitment 300 has been coupled to the coupling means of the manifold system 230, a preliminary cleansing operating mode is preferably carried out for each new container assembly 210 to prevent immediate contamination of the dispensing line 620 when a new container assembly 210 is put in place.

Further details regarding the manifold 230 and sanitary manifold 200 is described in co-pending US patent application Serial No. 10/187,939 by Peter W. Carhuff et al. filed June 28, 2002 entitled "SANITARY MANIFOLD SYSTEM AND METHOD FOR HYGIENICALLY DISPENSING FLUIDS" which, is incorporated herein by reference in its entirety.

In further accordance with the invention, an automated food product dispenser is provided wherein the interface connection is adapted to engage the food product reservoir wherein the food product (e.g., a microbiologically sensitive fluid) reservoir includes a flexible hose portion and a fitment.

As embodied herein and with reference to Figs. 10 to 12, the fitment 300 is composed of two main pieces, namely a first body member 301 and a ring-shaped sleeve 302 which when assembled and secured together to a terminal part or end 303 of hose 212 form a fluid tight assembly between the fitment 300 and the hose 212.

As shown in Fig. 11, the first body member 301 of the fitment 300 includes a portion of tube or socket 304 that extends along a longitudinal axis I. The socket

304 forms a tubular engaging surface with an external section that is configured to engage with the internal diameter of the hose 212. Preferably, hose 212 is made of resilient plastic material that slightly stretches to fit snugly onto socket 304. A terminal abutting wall 305 is provided at a first end of the socket 304 that demarcates a central fluid inlet 306 of axis I. When the hose 212 is fitted onto socket 304, the hose 212 abuts abutting wall 305.

The fitment further comprises a second member 307 that is a sleeve preferably having the form of a ring with an internal bore 308 forming a second engaging surface with the hose end. The bore of the sleeve 307 is adapted to snuggly engage the external surface of the hose end so as to create a fluid tight connection as shown in Fig. 12. More particularly, the socket 304 and bore 308 have differing surface shapes arranged to form wedging on the end of hose 212 so that hose 212 can resist disengagement upon pulling. In a preferred embodiment, socket 304 possesses an engaging surface 309 that progressively tapers in the direction of hose 212 to form an inclination θ_1 with respect to the longitudinal axis I. Similarly, bore 308 has an engaging surface 310 that progressively tapers in the same direction but at an inclination θ_2 that is greater than θ_1 so as to create a wedge area 320 that pinches hose 212 proximate the external radial surface 311 of the sleeve 307. Hence, hose 212 is properly secured between socket 304 and sleeve 307 while it resists a pulling force in a longitudinal direction defined by "T". Sleeve 307 further supports a coupling means 312 configured to engage with a retaining means of a dispensing line. When fitment 300 is secured to a dispensing line by the coupling means 312, a longitudinal force applied to hose

212 in a direction T results in sleeve 307 tightening down even more on hose 212, thereby holding hose 212 in place within fitment 300. The external diameter D of hose may be, for example, usually of about 1 to 1.5 cm; whereas the fitment length L may usually vary from about 0.5 to 1.2 cm. Excellent results have been obtained with a D of 1.2 cm and a L of 0.8 cm. The fitment is preferably made of food grade plastic such as polyolefins, polyamides, polystyrenes or tetrafluoropolyethylenes. Further details regarding the fitment and the manner in which it interacts with the manifold is described in co-pending US patent application Serial No. 10/187,941 by Peter W. Carhuff filed June 28, 2002 entitled "HOSE FITMENT FOR DISPOSABLE FOOD CONTAINER" which, is incorporated herein by reference in its entirety.

The invention also provides for different methods of using a dispenser in accordance with the invention. The most preferred embodiments of these methods are presented in the following Examples.

The invention also provides for a computer program in machine readable format containing instructions to operate a dispenser in accordance with the invention. The computer program may be embodied either in software or in hardware, such as a memory chip. The computer program may be written using well known techniques as is well known in the art and converted into machine code. The computer program in accordance with the invention has instructions therein for operating the dispenser. Preferably, the instructions in machine readable format will be contained on a computer chip in the dispenser 100 for controller 1000 to access when control panel is operated by an operator. Thus, when an operator presses a button on control panel 1100 to

dispense a food product or perform a cleaning operation, for example, the computer chip containing the instructions in machine readable format will be accessed by the controller to operate the dispenser 100. However, the computer program may also be embodied in a software program and run from a computer located inside or outside of the device.

Also, the machine readable program may be configured so that cleaning operations can be performed automatically in accordance with the invention during specified time intervals. The machine readable program may thus be configured to operate in conjunction with a timer to carry out periodic operations. In the Examples below, it is preferred that controller 1000 perform all of the actions in operating the device unless it is specified that an operator is to perform a task. However, an operator could perform any of the operations (such as opening or closing a valve) manually as is dictated by the convenience and needs of the operator. Furthermore, controller 1000 need not be physically embodied in control panel 1100. Controller 1000 is preferably located inside dispenser 100, but may also be located outside of dispenser 100.

Moreover, the controller 1000, delivery mechanism and cleansing mechanism 700 can be configured to switch between the dispensing of servings of food product and a cleansing operation without substantial intervention from an operator. As described herein, dispenser 1000 can be configured to operate automatically. The controller 1000 can be programmed, for example, to dispense one or more beverages, and then initiate a cleansing operation. The operation can be initiated automatically, or can be initiated by sending a signal to an annunciator to indicate to an operator to

initiate a cleansing cycle. Thus, the system can be operated without substantial input from an operator.

The controller 1000 is preferably operably associated with the cleansing mechanism 700 (such as a clean in place system) for activating the cleansing mechanism to cleanse the portion of the food delivery mechanism automatically in response to predetermined conditions. Such conditions can be based on, for example the time the dispenser was last used, as well as the type of food product that was most recently dispensed. For example, it may be desirable to perform a cleansing operation more frequently where the most recent food product dispensed included microbiologically sensitive material (e.g., a milk-based product). In contrast, longer intervals may be adequate to maintain sanitary conditions when somewhat less sensitive materials are dispensed.

These predetermined conditions can exist at a plurality of intervals during a day. For example, during normal business hours of a restaurant or a cafeteria, when dispenser 100 is in regular use for dispensing beverages, short cleansing operations (e.g., 1-5 minutes) can be performed to minimize growth of biological material in dispenser 100, but not substantially interrupt usage of dispenser 100 for an extended period of time.

Additionally, controller 1000 can be configured to prompt an operator to activate a cleansing operation in dispenser 100 in response to predetermined conditions, or can do so automatically without intervention of an operator. Controller 1000 can also be configured to verify to an operator that a cleansing operation is taking place, or has completed.

In accordance with this aspect of the invention, dispenser 100 can include an annunciator 1400, wherein the controller 1000 is operably associated with the annunciator 1400 to cause the annunciator 1400 to prompt an operator to activate a cleansing operation. The annunciator can include, for example, an indicator light that lights in response to the controller, and/or a buzzer or other device that can create an audible sound, or may even take other forms such as sending a message to an operator by way of radio frequency, electronic mail, etc. The annunciator 1400 can be located within controller 1000 (Fig. 1) or be located external to it (Fig. 3).

The controller 1000 can also be configured to automatically determine when a cleansing operation will begin and sending a cleansing start signal to initiate the cleansing operation. The cleansing start signal can be configured to automatically start a cleansing operation, by, for example, activating the cleansing mechanism 700. Alternatively, the cleansing start signal can be configured to activate the annunciator 1400, thus notifying an operator to activate a cleansing operation as described above.

The dispenser 100 can further include a timer configured for timing intervals between the cleansing operations, wherein controller 1000 is associated with the timer for activating the cleansing mechanism 700 based on the timed intervals. Moreover, dispenser 100 can also include at least one sensor in communication with controller 1000. Controller 1000 can be configured to activate a cleansing operation (e.g., a sanitizing operation) based on information received from at least one of the timer and sensor.

The sensors can include temperature sensors, conductivity sensors, proximity sensors, limit switches and the like.

Temperature sensors 991 can be provided, for example, in the CIP reservoir, or buffer tank 980 and on hot water tank 751, as depicted in Fig. 1. The reservoir 980 can be provided with a heater 993 as depicted in Fig. 1. These sensors can be configured to "lock out" the system if the water temperature is too low for CIP, hot water rinsing, and dispensing hot beverages. Thermostats may also be provided for the heat sealing of food product (e.g., milk) bags/containers and associated tubing during changing operations.

Conductivity sensors 995 can be employed, for example, as a level sensor in reservoir 980 or hot water tank 751 or in detergent container 987a or its accompanying feed line to reservoir 980 to sense the presence of detergent.

Proximity sensors 996 (Fig. 1) can be provided to detect the contents of different food product source containers such as reservoir 211 via weight measurement (e.g. via a spring system), and to ensure proper fitment alignment and connection such as for fitment 300.

Limit switches 997 may be provided to limit movement of spear 743, for retracting dispensing nozzle 500, and for pinch valve 260 (Fig. 1).

Each of the sensors and limit switches are preferably operably connected to controller 1000 for performing dispensing and cleansing operations.

Controller 1000 can be configured to perform first and second cleansing operations that are different from each other using cleansing mechanism 700. Controller 1000 can be configured to automatically operate cleansing mechanism 1000 to selectively conduct

the first or second cleansing operation. For example, controller 1000 can be configured to conduct a sanitizing operation followed by a second operation that includes cleaning and sanitizing together. Controller 1000 can also be configured to conduct a cleansing operation followed by a sanitizing operation. The sanitizing operation can be conducted several times per day and the cleaning and sanitizing operation can be performed daily, or preferably at night during non-business hours. A cleansing operation conducted using a detergent, a caustic or acidic material, or combination of detergent and caustic material, followed by a hot water cleansing operation that sanitizes the dispenser. Moreover, sanitizing using hot water can be performed several times per day without using other cleansing agents.

The dispenser 100 can also be configured to dispense different amounts of food product. For example, the dispenser 100 can be configured to dispense servings of up to about 10 servings at a time sized preferably for individual consumption, between 2 and 8 servings at a time, between 3 and 5 servings at a time, or may be configured to dispense a single serving at a time.

As depicted herein, dispenser 100 is a food service machine that dispenses products for individual consumption intended for, but not limited to, use in a restaurant, cafeteria and/or office-type setting, where as many as several hundred drinks could be dispensed over the course of a business day. Dispenser 100 is not intended for use in mass production and packaging of food product materials such as part of an assembly line in a factory setting dispensing thousands of food products daily.

Dispenser 100 can further include a dispenser housing 1500 (Fig. 3) that houses the food source, food

conduit, dispensing mechanism and cleansing mechanism, and optionally, the controller. Since dispenser 100 can be so configured as to be self-contained, it is not necessary to connect or disconnect an external source to perform a cleansing or dispensing operation.

The cleansing mechanism is preferably operatively associated with the food conduit and dispensing path and is configured to cleanse each of the food conduit, dispensing mechanism and cleansing mechanism. Moreover, dispenser 100 is preferably configured so that all food contact surfaces can be cleansed by cleansing mechanism 700.

EXAMPLES

The following examples are provided to illustrate preferred operating modes of the automated food dispenser in accordance with the invention. Each of these operating modes is for exemplary purposes only, and in no way are intended to limit the scope of the invention. For example, while many of the embodiments described below are directed toward a milk/cappuccino dispenser, the dispenser 100 can be configured to dispense many different types of food products, including refrigerated and non-refrigerated food products, microbiologically sensitive and non-microbiologically sensitive food products and the like.

EXAMPLE I - NEW RESERVOIR CONNECTION

For purposes of illustration only, and with reference to Figs. 1-3, an operating mode of the automated food dispenser in accordance with the invention will now be illustrated wherein a new reservoir 211 will be installed to replace an empty one.

In this example, reservoir 211 is to be replaced by an operator. As embodied herein, a machine operator presses a button 1110 on control panel 1100 to

indicate that the reservoir 211 will be replaced. Pinch valve 216 then is opened. In this embodiment a second pinch valve 260 is spring loaded by tension spring 263 and is opened manually by pulling the pinching member 261 away from the pinch block 262 to allow the hose 212 and reservoir 211 to be removed.

An actuator 762 on manifold 230 is then energized, moving projection member 738 and spear 743 backward, away from the fitment 300 area. When the spear 743 has retracted, the actuator 762 is de-energized. Electromagnetic actuator 544 of the dispense nozzle 500 then is energized, bringing the dispenser nozzle 500 to the cleansing position. Once the nozzle 500 is in this position, the actuator 544 is de-energized.

Next, fitment 301 (with membrane 350 intact) on the end of hose 212 is then slid into the holder 766 on the manifold 230 of the dispenser 100. The holder 766 is closed manually by twisting a retaining nut 768, clamping down on the fitment 300 and pulling it snug against the manifold 230. The tubing from the reservoir assembly 210 is threaded into the pinch valves 260 and 216 as well as the supply peristaltic pump 203.

Hot water valve 750 then is opened, allowing hot water 820 to flow through projection member 738 of the manifold 230, across the face of the fitment membrane 350, into the mixing bowl 406. The whipper 409 is turned on and drain valve 930 is opened, forcing hot water 820 to flow through the whipper 406, nozzle 500, and to the drain 940 through the drain valve 930. Hot water 820 should now be flowing from the hot water supply valve 750 all the way through the system to drain through valve 930, sanitizing the flowpath that it traverses.

This begins sanitization of the milk supply and product area, including the membrane 350 on the fitment

300. The membrane 350 is still intact. This sanitizing flow of hot water 820 will preferably continue for a predetermined time, preferably about 1-2 minutes. After the predetermined time has elapsed, valve 750 is closed. Shortly thereafter, preferably on the order of several seconds later, whipper 409 shuts off. Valve 930 then is closed. Actuator 544 then is energized again, bringing the dispenser nozzle 500 back to the dispensing position, and then is de-energized. This is followed by the closing of pinch valve 216. Next, actuator 762 is energized, pushing projection member 738 with spear 743 against the fitment 300 and punctures membrane 350. Actuator 762 then is de-energized. After a short delay, preferably on the order of a second, actuator 762 again is energized, moving the projection member 738 with spear 743 back away from the fitment 300 area. Once the spear 743 is in this position, the actuator 762 is de-energized. At this point, the reservoir 211 has been replaced and its contents are ready for dispensing, discussed in detail in Example II below.

EXAMPLE II - PRODUCT DISPENSING

For purposes of illustration only, and with reference to Figs. 1-3 and 13, an operating mode of the automated food dispenser in accordance with the invention will now be illustrated wherein food product is dispensed by the dispenser.

In this example, the dispenser is operated by an operator to dispense a milk-based cappuccino drink food product. As embodied herein, a machine operator presses a button 1120 for cappuccino on the control panel 1100 as the product selection. In response to the command, controller 1000 opens valve 216 and is turned on peristaltic pump 203 to begin flow of milk based fluid

211a. The pressure generated by the pump 203 forces milk based fluid 211a past the spring loaded pinch valve 260.

Next, controller opens hot water supply valve 950 to begin a flow of hot water 820. Hot water 820 flows through water feed line 960 and milk based fluid 211a begins to flow through dispensing line 620 to the mixing bowl 406, where they begin to mix. The flowpath of milk based fluid 211a is signified by flowpath 1292 in Fig. 13 while the flowpath of hot water 820 is indicated by flowpath 1290. Controller 1000 then is turned on whipper 409. As they mix, the milk based fluid 211a and hot water 820 flow downward from mixing bowl 406 into the whipper 409 where they are whipped together into a substantially uniform mixture, and finally flow through the dispensing nozzle 500 into the cup 516. This step occurs for a pre-determined period to achieve an adequate amount of milk mixture 211b. After this period, the pump 203 is turned off by controller 1000. Shortly thereafter, preferably on the order of a second, whipper 409 is turned off, and coffee pump 411 is turned on. At this point, coffee and hot water 820 flow into the mixing bowl 406, through the whipper 409 (which is not running at this point), and through the nozzle 500 and into the cup 516, for a pre-determined time to achieve dosage. The flowpath of coffee in this operation is indicated by flowpath 1293 in Fig. 13, and the flowpath of hot water 820 is indicated by flowpath 1290.

After the coffee dosage has been achieved, coffee pump 411 is turned off. After a small delay on the order of several seconds to obtain an adequate amount of hot water 820 necessary for the drink recipe, the hot water supply valve 950 is turned off. It should be noted that, adding the remainder of the hot water 820 after the milk mixture 211b and coffee have been added to cup 516

facilitates recovery of most of the milk mixture 211b and coffee from the fluid path 600 of the system by washing the milk mixture 211b and coffee into the cup 516.

Next, showering valve 413 is turned on by controller 1000 for several seconds to send water 810 through spray nozzle 414. This flowpath is indicated by flowpath 1295 in Fig. 13. Spray nozzle 414 sprays the foam on the top of the cup, washes the top layer of foam to whiten it, and breaks larger bubbles and moistens the foam to improve its appearance. After a pre-determined time, showering valve 413 is turned off by controller 1000 to stop the spray. After a short delay, preferably on the order of a second, actuator 544 is turned on, moving the dispensing nozzle 500 into the cleaning and/or sanitizing position. When the nozzle 500 reaches that position, actuator 544 shuts off.

Next, hot water supply valve 950 is opened by controller 1000 to allow hot water 820 to flow into the mixing bowl 406. Whipper 409 is turned on at low speed, and drain valve 930 is opened. Hot water 820 flows through the mixing bowl 406, whipper 409, and dispensing nozzle 500 to rinse any residual food product from the system. The flowpath 1290 of the hot water 820 is shown in Fig. 14. The rinse goes to the drain 940 via valve 930. This hot water 820 also aids in maintaining system hygiene by rinsing and killing microorganisms that might be in the system. After a short delay preferably on the order of several seconds, hot water supply valve 950 is turned off. After several more seconds, whipper 409 is turned off and drain valve 930 is closed by controller 1000. Nozzle actuator 544 is then energized by the controller, moving the dispensing nozzle 500 to the dispensing position. When it has reached that position, actuator 544 is de-energized by the controller 1000.

EXAMPLE III - HYGIENE MAINTENANCE

For purposes of illustration only, and with reference to Figs. 1-3 and 6, an operating mode of the automated food dispenser in accordance with the invention will now be illustrated wherein the parts of the fluid path 600 that including the dispensing line 620 and dispensing nozzle 500 are flushed periodically for purposes of hygienic maintenance. Controller 1000 can be programmed to perform this function at any specified interval. Preferably, such hygienic maintenance is performed after a pre-determined period of dispenser inactivity has been reached. For example, if the dispenser has not been used to dispense drinks for a period of time, such as two to four hours, the dispenser will then carry out a hygienic maintenance operation.

First, actuator 762 on the manifold 230 is energized, pushing the projection member 738 with spear 743 toward the fitment 300. The spear tip 743a will protrude into the fitment 300. Once the spear 743 is in this position, the actuator 762 is de-energized.

Next, pinch actuator 267 is energized, applying additional pressure on the spring loaded pinch valve 260 to ensure no leakage of hot water 820 through pinch valve 260 into the sterile milk area. Once the pinching member 261 has reached a pre-determined point (and therefore a predetermined closing pressure), the pinch actuator 267 is de-energized.

At this point, actuator 544 of the dispensing nozzle 500 is energized, bringing the dispenser nozzle 500 to the cleaning and/or sanitizing position. Once the nozzle 500 is in this position, the actuator 544 is de-energized. This is followed by opening hot water bypass valve 750, and drain valve 930. Hot water 820 now flows from the hot water tank 751, through valve 750, through

the projection member 738 of the manifold 230, past the spear 743, into the region of fitment 300, through manifold 230, out through the sanitary manifold dispensing line 620, into the mixing bowl 406. The mixing bowl 406 fills up with hot water 820, which then over flows mixing bowl 406 and flows into the skirt 410, through overflow line 965, and into the drain 940 via drain valve 930. Pinch valve 260 stays closed in this exemplary operating mode, keeping hot water 820 from entering the hose 212 from the reservoir 211 and mixing with and contaminating milk based fluid 211a in the reservoir. Hot water 820 overflow of the mixing bowl continues for a pre-determined time, typically about 30 seconds and then stops.

After the hot water 820 overflow period ends, the whipper 409 is turned on, pumping hot water 820 from the mixing bowl 406 through the dispensing nozzle 500, and out to drain 940 via valve 930. This flow of hot water 820 preferably continues for a desired time interval, preferably one minute, even more preferably for two minutes. At the end of that time interval, hot water supply valve 750 is closed. Shortly thereafter, preferably after a two second delay, the whipper 409 is turned off, and drain valve 930 is closed. Actuator 762 on the manifold 230 is energized, pulling the projection member 738 with spear 743 away from the fitment 300. Once the spear 743 is in its retracted position, the actuator 762 is de-energized. Nozzle actuator 544 then is energized, moving the dispensing nozzle 500 to its dispensing position. When dispensing nozzle 500 has reached its dispensing position, actuator 544 is de-energized.

Finally, pinch actuator 267 is energized, relieving the mechanical pressure added to the pinch

valve 260 earlier. Valve 260 remains closed from pressure attributable only to the tension spring 263. Once the pinching member 261 has reached a pre-determined point, the pinch actuator 267 is de-energized. At this point, the operation is complete and the system has been rinsed and/or sanitized.

In accordance with this example, the dispenser can be provided with a temperature sensor 991 (See Fig. 18) that is configured to measure the temperature of the water in the circulation path. A heating device such as an in-line heater 990 may also be provided wherein the controller 1000 is configured to control heater 990 to heat the water in response to information received from the temperature sensor. In this manner, a recirculating flow of sanitizing hot water flow can be maintained for extended periods of time (e.g., 30 minutes) without the need for a large water tank. However, a large water tank can be provided in appropriate embodiments. By incorporating heaters 990 and possibly other heaters within dispenser 100, it is not necessary to rely on tank 751 exclusively for hot water. In fact, a proper combination of inline heaters can be used in lieu of tank 751, if desired. Such an option can serve to reduce the size of the dispenser, and can provide hot water on demand, which eliminates the need to maintain a supply of hot water, which can be a waste of energy.

When performing hot water sanitization as disclosed herein, hot water is directed along a fluid path in sanitizing association with a food delivery mechanism in a food product dispenser at a sufficiently high temperature and under conditions for sanitizing at least a portion of the food delivery mechanism.

Applicants have discovered that hot water, used alone, can serve as a wholly adequate sanitizing agent

such as for periodic sanitizing between intervals lasting up to a few hours. This is extremely advantageous, since it eliminates the need to rely on detergents and/or caustic materials for purpose of cleaning and sanitization, at least for semi-daily sanitizing operations. In accordance with this discovery, Applicants have determined that growth of microbiological organisms within a dispensing device such as dispenser 100 can be sufficiently minimized by directing hot water therethrough at specific temperatures, flow-rates and frequencies for particular durations.

It has been discovered that it is advantageous to direct water through a dispenser at an average fluid velocity between about 0.2 m/s and 2.0 m/s. Preferably, the water is directed at an average fluid velocity between about 0.4 m/s and 0.8 m/s. Exemplary volume flow rates include from about 50 ml/min to about 2500 ml/min; more preferably from 500 ml/min to about 1200 ml/min; most preferably about 900 ml/min.

Similarly, it has been discovered to be advantageous to direct water through a dispenser that has been heated to a temperature between about 70C and 95C, more preferably between about 75C and 95C. Even more preferably, the water is directed at a temperature between about 80C and 90C. Water is sufficiently hot for purposes of the invention as long as it is hot enough to reduce microbiological deposits. Thus, a slightly lower water temperature will be sufficient for sanitizing if used for a slightly longer time.

During normal business hours preferably while the dispenser is operated and is available for dispensing food product, it has been discovered that growth of microbiological organisms is minimized if hot water meeting the above criteria is directed once about every 2

to 4 hours for between about 20 seconds and 10 minutes, more preferably between about 30 seconds to 5 minutes. Even more preferably, the water is directed from about 1.5 to 4 minutes, and even more preferably from 1.75 minutes to 3 minutes. This is advantageous because it ensures sanitary conditions of dispenser 100 without requiring an outage that significantly interrupts with machine operation for extended periods during normal business hours, since it is often not practical to clean manually or automatically (via a 20-60 minute cleaning cycle) in the middle of a business day. The duration of a hot water cleansing cycle for sanitization depends on the frequency of the hot water sanitization cycle. The longer the cycle, the less frequent the cycle has to be repeated. Less frequent cycles, in turn, require cycles with longer durations.

Hot water sanitization can also be employed during non-business hours as well as a part of a CIP routine. For example, hot water can be directed twice a day (e.g., once every 8-12 hours) for between about 1 and 50 minutes, more preferably between about 5 and 30 minutes. Even more preferably, the water is directed for about 10 to 20 minutes at the flow rates and temperatures prescribed above. The water can be directed through heating device 990 while it is directed through the fluid path during extended sanitization procedures.

As a further variant, when a heating device such as 990 is provided, it is possible to begin a cleansing operation with water at a lower temperature, and slowly increase the temperature of the recirculating water using heater 990. Starting a cleansing operation with cooler water (e.g., 25C) and heating it slowly during recirculation can produce more useful results than using hot water (e.g. 80C-90C) from the beginning of the

operation. When such hot water is introduced into the fluid path immediately, it can actually cause proteins (e.g., from a milk-based fluid) to adhere or "burn onto" the walls of the tubing. By starting with water at a lower temperature, these proteins could be swept up and removed before they are caused to deposit by scalding water. As an additional variant, the system can be flushed by cooler water, and then sanitized to help minimize deposition of protein materials.

A variety of different heating devices 990 may be used. While an in-line resistive heater has been depicted it is also possible to use an inline heat-exchanger that heats the cleansing fluid using hot water, as well as other heat sources. It should be emphasized that the present invention also contemplates cleansing such devices. For example, the system of the present invention can be used to descale a heat exchanger by running acidic solution therethrough.

EXAMPLE IV - CLEAN-IN-PLACE

For purposes of illustration only, and with reference to Figs. 1-3 and 6, an operating mode of the automated food dispenser in accordance with the invention will now be illustrated wherein the dispenser cleans itself using a cleansing liquid.

In this example, the controller 1000 of the dispenser 100 of the invention is programmed to automatically carry out a Clean-In-Place ("CIP") cycle. A CIP cycle can also be initiated by an operator. CIP cycles are preferably used during particular points in the day, preferably during non-business hours. Short duration hot-water rinses are preferably used during business hours, since they can be effective, while maintaining availability of the dispenser for dispensing food products.

As embodied herein, controller 1000 begins the CIP cycle by opening hot water CIP valve 985, mixing bowl rinse valve 955, and shutoff valve 989, which are initially closed. Hot water 820 now flows from the hot water tank 751, through CIP valve 985 into the CIP reservoir 980. Pinch actuator 267 is energized, applying additional pressure on the pinch valve 260 to ensure no leakage of hot water 820 through the valve into the sterile milk area. Once the pinch has reached a pre-determined point (and therefore closing pressure), the pinch actuator 267 is de-energized.

Next, actuator 762 on the manifold 230 is energized, pushing the projection member 738 with spear 743 toward fitment 300. The spear tip 743a will protrude into the fitment 300. Once the spear 743 is in this position, the actuator 762 is de-energized.

Once the CIP reservoir 980 has filled (as indicated by a conductivity level sensor 982), CIP pump 988 is turned on, pumping hot water 820 through shutoff valve 989, mixing bowl rinse valve 955, and into the mixing bowl 406 via the water feed line 960 to the mixing bowl 406. The mixing bowl 406 fills up with hot water 820, which then over flows into skirt 410 and into the overflow line 965, and into the drain 940 via drain valve 930. Pinch valve 260 stays closed, keeping hot water 820 from entering the hose 212 from the reservoir 211 and mixing with (and contaminating) the milk based fluid 211a in the reservoir 211.

Next, the whipper 409 pulses on for short durations. A preferable cycle is having the whipper 409 turn on for ten seconds, followed by whipper 409 being turned off for ten seconds. While the whipper 409 is running, hot water 820 flows through the whipper 409 and the dispensing nozzle 500 rather than through the mixing

bowl 406 and overflowing through skirt 410 and overflow line 965.

After a pre-determined period of time that is preferably about 1 minute, sanitary manifold 200 CIP valve 755 is opened, and the mixing bowl rinse valve 955 is closed. Rinsing now goes through the manifold 230. During this time, the whipper 409 continues to pulse on and off for short durations as described above.

After a pre-determined period that is preferably about one minute, the CIP pump 988 is turned off, the whipper 409 is turned off (and stops its intermittent pulsing), and drain valve 930 is closed. The hot water CIP valve 985 is then opened to refill the CIP reservoir 980 with hot water 820. Once the CIP reservoir 980 has been filled (as indicated by a conductivity level sensor 982), the cleansing valve 987 is opened to permit cleansing concentrate 984 to flow into the CIP reservoir 980 to make a cleansing solution 984a. After a pre-determined period of time, cleansing valve 987 is closed.

Next, CIP pump 988 is turned on, pumping hot cleansing solution 984a from the CIP reservoir 980 through shutoff valve 989, through the manifold 230, and into the mixing bowl 406. The mixing bowl 406 fills up with cleansing solution 984a. The cleansing solution 984a then overflows mixing bowl 406 into skirt 410 and flows into the overflow line 965, and into the CIP reservoir 980 via the recirculation valve 970. Pinch valve 260 stays closed during this operation, keeping cleansing solution 984a from entering the hose 212 from the reservoir 211 and mixing with and contaminating the milk based fluid 211a.

The whipper 409 again pulses on for short durations (e.g., cycles of turning on the whipper 409 for

ten seconds followed by turning whipper 409 off for 10 seconds). While whipper 409 is running, cleansing solution 984a flows through the whipper 409 and the dispensing nozzle 500 rather than overflowing mixing bowl 406 into skirt 410 and flowing through overflow line 965.

After a pre-determined period of time, preferably about three minutes, the CIP valve 755 is closed, and the mixing bowl rinse valve 955 is opened. Cleansing solution 984a then flows through the water feed line 960 to the bowl 406. While the flow of cleansing solution 984a occurs, whipper 409 continues to pulse on and off for short durations of time.

Next, after a pre-determined period of time, preferably about three minutes, the whipper 409 is turned on, preferably at a relatively low, constant speed, without pulsing, and drain valve 930 is opened while recirculation valve 970 is closed. This step pumps the cleansing solution 984a from the CIP reservoir 980, through the system, and to the CIP drain 941 via CIP drain valve 981, to purge the bulk of the cleansing solution 984a from the system. After a pre-determined period, preferably about one minute, the CIP pump 988 is turned off and the whipper 409 is turned off. Next, CIP reservoir drain valve 981 is opened to drain any remaining cleansing solution 984a from the CIP reservoir 980. CIP reservoir drain valve 981 stays open for a relatively short time, preferably about 15 seconds.

At this point, hot water CIP valve 985 is opened to refill the CIP reservoir 980 with hot water 820. Once the CIP reservoir 980 has been filled with hot water 820 (as indicated by a conductivity level sensor 982), CIP pump 988 is turned on, pumping hot water 820 through shutoff valve 989, mixing bowl rinse valve 955, and into the mixing bowl 406 via water feed line 960.

Alternatively, hot water could be supplied directly from hot water tank 751 to mixing bowl 406 by way of hot water supply valve 950.

The mixing bowl 406 is filled with hot water 820, which then over flows into skirt 410, into the overflow line 965, and into the drain 940 via drain valve 930. Pinch valve 260 stays closed, keeping hot water 820 from entering hose 212 from the reservoir 211 and mixing with and contaminating milk based fluid 211a. Whipper 409 then pulses on and off for short durations, preferably for about 10 seconds on and 10 seconds off. While the whipper 409 is running, flow goes through the whipper 409 and the dispensing nozzle 500 rather than through the mixing bowl overflow line 965.

After a pre-determined period, preferably about two minutes, CIP valve 755 is opened, and the mixing bowl rinse valve 955 is closed. Hot water 820 now goes through the manifold 230, rinsing it. After a pre-determined period, preferably about one minute, the whipper 409 is turned on, preferably at a steady, relatively slow speed. Water supply valves 945 and 950 turn on for a short duration, preferably about five seconds to rinse the valve ends. During this step, the rinse water 850 from the CIP reservoir 980 is pumped through the system, and through CIP drain valve 981 to CIP drain 941. Hot water 820 obtained directly from hot water tank 751 could also be run through the system for rinsing, rather than using the CIP pump 988 to pump rinse water 850 through the system.

Next, after a pre-determined period, preferably about one minute, the CIP pump 988 is turned off. The hot water bypass valve 750 is opened to allow further rinsing and hot water sanitization of the manifold 230, mixing bowl 406, whipper 409, and dispensing nozzle 500.

After another pre-determined period, preferably about one minute, the hot water bypass valve 750 is closed. After a short delay, preferably about two seconds, the whipper 409 is turned off, and drain valve 930 is closed. Actuator 762 on the manifold 230 is then energized, pulling the projection member 738 with spear 743 away from the fitment 300. Once the spear 743 is in its retracted position, the actuator 762 is de-energized. Nozzle actuator 544 is then energized, moving the dispensing nozzle 500 to the dispensing position. When nozzle 500 has reached its dispensing position, actuator 544 is de-energized. Valve 981 is then opened for a predetermined time, preferably fifteen seconds to drain any remaining rinse water 850 from the CIP reservoir 980 through CIP drain 941. At the end of the predetermined time, valve 981 and CIP shutoff valve 989 are closed.

Finally, pinch actuator 267 is energized, relieving the mechanical pressure added to the pinch valve 260 earlier. Pinch valve 260 remains closed from the pressure attributable to tension spring 263 only. Once the pinching member 261 has reached a pre-determined point, the pinch actuator 267 is de-energized. At this point, the exemplary system CIP cycle is complete.

EXAMPLE V - RESERVOIR REMOVAL

For purposes of illustration only, and with reference to Figs. 1-3, an operating mode of the automated food dispenser in accordance with the invention will now be illustrated wherein the reservoir assembly 210, as embodied herein, is removed by an operator.

To begin this procedure, the machine operator presses a button 1130 on the control panel 1100 to indicate the currently loaded reservoir assembly 210 is to be removed. In response to this operator input,

controller 1000 energizes pinch actuator 267, which applies additional pressure on the pinch valve 260 by moving pinching member toward 211, compressing it. Once the pinching member 261 has reached a pre-determined point (and therefore closing pressure), the pinch actuator 267 is de-energized.

Next, heating element 290 is turned on by controller 1000, for a pre-determined period of time, preferably about thirty seconds to melt shut hose 212. The heating element 290 is then turned off. Hose 212 is now heat sealed, rendering the reservoir 211 unusable, and preventing any milk based fluid 211a remaining in the reservoir 211 from leaking out onto the operator or other components of dispenser 100.

Next, pinch actuator 267 is energized to move pinching member 261 backward from hose 212, thus relieving the mechanical pressure added to the pinch valve 260 earlier. Valve 260 remains closed from the pressure from tension spring 263 only. Once the pinching member 261 has reached a pre-determined point, the pinch actuator 267 is de-energized. Valve 216 is then opened.

The operator next opens the manifold 230 retaining nut 768 manually by lifting a lever. The fitment 300 on the end of the hose 212 is slid out of engagement with the holder 766 on the manifold 230 of the dispenser 100. The tubing from the reservoir 211 is unthreaded from the pinch valves 260 & 216 as well as the supply peristaltic pump 203. At this point, the dispenser 100 is ready for a new milk bag.

EXAMPLE VI - DAILY HOT WATER SANITIZATION

An additional schematic showing flowpaths for hot water 820 flow in an additional exemplary embodiment of a daily hot water sanitizing flowpath through dispenser 100 in Figs. 15 and 16. As embodied in Fig.

15, flowpath 1210 is established to direct hot water from hot water supply module 1201 (containing hot water tank 751) to mixing bowl 406. Flowpath 1220 is similarly established between water supply module 1201 and manifold 230. Hot water 820 flows through manifold 230, out through dispensing line 620 into mixing bowl 406. Hot water 820 from flowpaths 1210 and 1220 mix together in mixing bowl 406, and flow down through whipper 409 running at a low speed setting, and through nozzle 500 in its cleaning and/or sanitizing position to drain 940 via drain valve 930, thereby forming flowpath 1230. While this operation is ongoing, pinch actuator 267 is pressing pinching member 261 against pinch block 262 with a preselected force thereby holding hose 212 shut with a preselected pressure to prevent hot water 820 from contaminating milk based fluid 211a in reservoir 211. As indicated in Fig. 16, this operation may be done on a daily basis, preferably after a daily cleaning using a detergent solution, following a plurality of sanitizing rinses using hot water and dispense cycles of food product during the business day.

EXAMPLE VII - OTHER DAILY AND PERIODIC OPERATIONS

Variations of the operations described above can be carried out on dispenser 100 in accordance with the invention on a daily or other basis.

Example VII-A, Draining CIP Reservoir:

For example, the flowpath 1230 established through CIP drain valve 981 is illustrated in Fig. 17. As embodied herein, in further accordance with the invention, the CIP reservoir 980 is drained on a daily basis. When the CIP reservoir 980 is being drained, the CIP resistive heaters 990 and whipper 409 are preferably off and pinch actuator 267 is pressing pinching member 261 against pinch block 262 with a preselected force

thereby holding hose 212 shut with a preselected pressure.

Example VII-B, Circulation Cleaning Loop for Mixing Bowl:

Similarly, Fig. 18 shows an additional exemplary embodiment wherein flowpaths 1240, 1250 and 1260 are established on a daily basis as a recirculation cleaning loop for mixing bowl 406. As embodied herein, flowpath 1260 is established by CIP pump 988 being turned on along with CIP resistive heaters 990. This causes the cleansing fluid 984b in CIP reservoir 980 to become heated and flow into mixing bowl 406. The cleansing fluid 984b is caused to overflow into skirt 410 of mixing device 400 by pulsing the whipper 409 and/or modifying the flowrate in flowpath 1260. As a result, cleansing fluid 984b that has overflown mixing bowl 406 into skirt 410 drains through flowpath 1240 back into CIP reservoir 980. Additionally, cleansing fluid 984b also flows through whipper 409, nozzle 500 (in its cleaning and/or sanitizing position) while traversing flowpath 1250 back to CIP reservoir 980 to be recycled or drained. While this operation is ongoing, pinch actuator 267 is pressing pinching member 261 against pinch block 262 with a preselected force thereby holding hose 212 shut.

Example VII-C, Circulation Cleaning Loop for Milk Manifold:

Fig. 19 shows an additional exemplary embodiment wherein flowpaths 1250 and 1270 are established on a daily basis as a recirculation cleaning loop for manifold 230. As embodied herein, flowpath 1270 is established by CIP pump 988 being turned on along with CIP resistive heaters 990. This causes the cleansing fluid 984b in CIP reservoir 980 to become heated and flow through flowpath 1270 into manifold 230. After flowing through manifold 230, cleansing fluid 984b flows through

dispensing line 620 into mixing bowl 406. The cleansing fluid 984b then flows through whipper 409 and flowpath 1250 back to CIP reservoir 980 to be recycled or drained. While this operation is ongoing, pinch actuator 267 is pressing pinching member 261 against pinch block 262 with a preselected force thereby holding hose 212 shut with a preselected pressure to prevent hot water 820 from contaminating milk based fluid 211a in reservoir 211.

Example VII-D, CIP Reservoir Filling:

Fig. 20 shows an additional exemplary embodiment wherein flowpaths 1280 and 1285 are established on a daily basis to fill CIP reservoir 980. As embodied herein, flowpath 1280 is established between hot water supply module 1201 and CIP reservoir 980 to fill the reservoir by opening CIP hot water valve 985. Flowpath 1285 is established by opening cleansing valve 987 to cause cleaning concentrate 987b to flow from container 987a. Preferably, containers 986a and 987a are removable and can be replaced by the operator when necessary. Valves 987b and 985 are closed when predetermined amounts of cleaning concentrate and hot water, respectively, flow into CIP reservoir 980. While this operation is ongoing, pinch actuator 267 is pressing pinching member 261 against pinch block 262 with a preselected force thereby holding hose 212 shut.

Example VII-E, Milk Manifold Rinse During Inactivity:

Fig. 21 shows an additional exemplary embodiment wherein flowpaths 1230 and 1275 are established to rinse manifold 230 during inactivity of dispenser 100. As embodied herein, flowpath 1275 is established between hot water supply module 1201 and manifold 230 by opening hot water bypass valve 750. Hot water 820 then flows through flowpath 1275 passing through manifold 230 and dispensing line 620 into mixing

bowl 406. After flowing into mixing bowl 406, hot water 820 then flows through nozzle 500 (in cleaning and/or sanitizing position) through flowpath 1230 and out drain 940 via drain valve 930. While this operation is ongoing, pinch actuator 267 is pressing pinching member 261 against pinch block 262 with a preselected force thereby holding hose 212 shut with a preselected pressure to prevent hot water 820 from contaminating milk based fluid 211a in reservoir 211.

Example VII-F, Post Drink Rinse:

Fig. 14 shows an additional exemplary embodiment wherein flowpaths 1290 and 1230 are established after each drink is dispensed to flush mixing bowl 406 and dispensing nozzle 500. As embodied herein, flowpath 1290 is established between hot water tank 751 of hot water supply module 1201 and mixing bowl 406 by opening hot water supply valve 950. This causes hot water 820 to flow into mixing bowl 406. Whipper 409 is run on low speed in this example as the hot water 820 traverses flowpath 1230 through the whipper 409 and out drain 940 via drain valve 930.

EXAMPLE VIII - SAMPLE OPERATIONAL REGIMEN

In accordance with the invention, a sample cleaning regimen can be provided as indicated in Table I below:

TABLE I

CIP PROCESS SEQUENCE

TIME		STAGE	STEP				DESCRIPTION
Hour			#	SCREEN	DURATION		

0	0:00	Pre-Rinse	1	Prerinse Delay	30 s		Time to apply additional pressure to milk tubing pinch valve 260
	0:30		2	Pre-Rinse	60 s		HW Tank - Milk Manifold - Mixing Bowl - CIP Nozzle - CIP Tank
1							
	1:30		3	First Rinse	60 s		HW Tank - Milk Manifold - Mixing Bowl - CIP Nozzle - CIP Tank
2							
	2:30		4	Fill Tank	115 s		Fill CIP Tank 980 with water until level sensor activates addition of cleansing solution
3							
4	4:25	Clean-sing	5	Add clean-sing	30 s		cleansing solution added from bottle to CIP Reservoir 980

	4:55		6	Circ to Milk	120 s		CIP Tank - CIP Pump - Milk Manifold - Mixing Bowl - CIP Nozzle - CIP Tank
5							
6							
	6:55		7	Circ to Bowl	120 s		CIP Tank - CIP Pump - Mixing Bowl - CIP Nozzle - CIP Tank
7							
8							
	8:55		8	Drain	30 s		Drain CIP Reservoir
9	9:25	Rinse	9	Milk Rinse	120 s		HW Tank - Milk Manifold - Mixing Bowl - CIP Nozzle - Drain
10							
11	11:25		10	Bowl Rinse	60		HW Tank - Mixing Bowl - CIP Nozzle - Drain
12	12:25		11	Drain	30		Drain flowpath, remove pressure from milk tubing pinch valve

	12:55			Off			

As seen in Table I above, different regimens are provided for performing different operations with dispenser 100. Instructions for performing these functions at the above specified intervals are preferably written into a computer program in machine readable format for controlling the dispenser 100.

EXAMPLE IX - REMOVAL OF MICROBIOLOGICAL MATERIAL

The following tests were performed to compare the performance of hot water sanitization with additional use of a cleansing fluid using detergent (in this case, Supra® detergent, available from the Ecolab Company). The tests were performed using a food product dispenser similar to the food product dispenser depicted in Figs. 1-21.

Example IX-A - Detergent and Hot Water Cleansing

The tests using detergent were performed beginning with a one-minute pre-rinse cycle of water at 90C at a flowrate of 900 ml/min. This was followed by applying a flow of detergent for three minutes at a fluid temperature between about 60C and 70C, at a detergent concentration level of 0.25% at volume flow rates varying between 860 ml/min and 1150 ml/min. The whipper 409 was pulsed for 30 second intervals separated by 15 second intervals of non-use. A final rinse was performed using hot water at 90C for 3 minutes at a volume flowrate of 900 ml/min. Results of various CIP conditions in cleaning a prototype RITA dispenser are shown in Table II:

TABLE II

Pre-Rinse	Supra detergent[1] (60-70 C, 3 min)	Whipper	Final Rinse H_2O

90°C, 900 ml/min	Conc. (%)	Vol. ml	Total flow ml/min	Line flow ml/min	Over-flow ml/min			90°C, 900 ml/min	(l)	Microbial reductions (log cfu/cm^2)
1 min	1.0	900	1050			on off	(30 s) (15 s)	3 min	4.5	4.0
1 min	0.25	900	1140			on off	(30 s) (15 s)	3 min	4.5	4.0
1 min	0.25	900	860	860		on off	(30 s) (15 s)	3 min	4.5	3.0
1 min	0.25	900	1070	1100 500	100 570	on off	(5 s) (15 s)	3 min	4.5	5.0
30 sec	0.25	450	1150*	540 1075	610 75	on off	(15 s) (5 s)	2 min 1 min (tap water)	2.7	2.0

*with steam injection during circulation.
Effective CIP protocols.

These conditions were effective in reducing microbial load recovered from the equipment. At a lower cleaning temperature (80°C) and detergent concentration (0.25%), the CIP performance remained effective as depicted in Table III:

TABLE III

Water/Detergent Temperature	Detergent (%)	VRB count (cfu/ml)	
90° C	0	2,1,2,1,4	2,2,2,0
	0.25	0,0,0,0,0	0,0,0,0
	0.50	0,0,0,0,0	0,0,0,0
80° C	0.25	0,0,0,0,0	0,0,0,0
	0.50	0,0,0,0,0	0,0,0,0

Based on these results, an exemplary CIP procedure comprises at least a hot water pre-rinse using water at a temperature in excess of 85C, a detergent concentration of about 0.5%, and a hot water final-rinse using water at a temperature in excess of 85C.

EXAMPLE IX-B - Hot Water Cleansing

In comparison to Example IX(a), results of a cleansing procedure using hot water alone as the cleansing

fluid in a dispenser similar to that depicted in Figs. 1-21 are shown in Table IV. The result indicates that, after a CIP procedure using hot water, microbial loads in the food product dispenser remain at acceptable levels during extended periods of dispenser non-use:

TABLE IV

Day	Cleaning	Microbial count (cfu/ml rinse water)
0	CIP, dispenser idle over weekend	
3	Rinse 5x25 ml sterile water	$1.2x10^3$
4	No CIP previous night, before hot water rinse [2]	$>10^4$
	After hot water rinse	$2.0x10^1$
5	CIP previous night, before hot water rinse	$2.5x10^2$
	After hot water rinse	$3.0x10^1$
6	CIP previous night, before hot water rinse	$1.0x10^2$
	After hot water rinse	<1.0

1 Dispensing 40 cups/day

2 Hot water rinse 90° C, 1 min, 900 ml/min.

Two further tests were performed to demonstrate the efficacy of sanitizing with hot water. The first test was performed using milk concentrate having a concentration greater than 1.0×10^6 cfu/ml of microorganisms. The results are presented in Table V:

TABLE V

	Microbial counts (cfu/ml)			
Day	Before HW	After HW rinse (1min)	Milo	CIP1
1				$2.3x10^3$
2	$1.7x10^4$	$1.0x10^2$		$<1.0x10^2$
3	$1.0x10^3$	$3.2x10^2$		$3.5x10^2$
4	$2.3x10^4$	$<1.0x10^1$		$7.0x10^1$

The second test was performed by dispensing one serving (e.g., a cup) of chocolate milk beverage each hour. A hot water rinse was performed at the beginning of each day for two minutes of duration at 90C at 900 ml/min, and a hot water CIP procedure was run at the end of each day. Four 50ml samples

of rinse water were collected for microbial analysis, the results of which are presented in Table VI:

TABLE VI

	Microbial counts (cfu/ml)			
Day	Before HW	After HW rinse (1min)	Milo	CIP1
1		$4x710^{2}$	$2.3x10^{3}$	$1.0x10^{1}$
2	$2.4x10^{3}$	$4.8x10^{2}$	$5.5x10^{2}$	$1.0x10^{2}$
3	$1.5x10^{4}$	$5.3x10^{3}$	$3.0x10^{4}$	$6.0x10^{2}$
4	$1.4x10^{3}$	$8.0x10^{2}$	$1.0x10^{6}$	$1.0x10^{3}$
4	$1.0x10^{6}$	$6.6x10^{3}$	$1.0x10^{7}$	

As is plainly evident, the use of hot water without an accompanying detergent rinse is extremely effective in reducing growth of microbiological materials. Fig. 22 herein depicts a two-minute hot water rinse showing the fluid temperatures reached in the different components of the dispenser (e.g., dispensing nozzle (e.g., 500), milk tube (e.g., fluid path 600), CIP drain (e.g., drain 940), bowl (e.g., mixing bowl b406) and overflow (e.g., skirt 410). All of these components are raised to a temperature in excess of 70C. Figs. 23 and 24 depict extended hot water CIP cycles. As can be seen, portions of the dispenser are raised to temperatures in excess of 80C, helping minimize growth of microbiological material.

As can be seen, the present invention, as described above and shown in the drawings, provides for more sanitary operation and greater ease of use than with prior art devices.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present system without departing from the spirit or scope of the invention. Thus, it is intended that the present invention include all such modifications and variations within the scope of the appended claims and their equivalents.